American Journal of Plant Sciences, 2025, 16(6), 831-863
https://www.scirp.org/journal/ajps
ISSN Online: 2158-2750
ISSN Print: 2158-2742

Non-Timber Forest Products Used by the Baka of Gribé (East-Cameroon)

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How to cite this paper: Mvogo Ottou, P.B., Ngouondjou Foze, T., Doumbe Makembe, L., Nguemale Belale, A.P., Noudiédié Kamgang, J.A., Ngotta Biyon, J.B., Ndiang, Z., Betti, J.L. and Priso, R.J. (2025) Non-Timber Forest Products Used by the Baka of Gribé (East-Cameroon). *American Journal of Plant Sciences*, **16**, 831-863.
https://doi.org/10.4236/ajps.2025.166058

Received: February 3, 2025
Accepted: June 24, 2025
Published: June 27, 2025

Abstract

This study aimed to make an inventory of the NTFPs used by the Baka community of Gribé, with the participation of 76 households and 178 informants. The ethnobotanical data collected from the semi-structured interviews were cleaned and analysed. The organs used to prepare the recipes were removed, and the specimens were identified. The NTFP flora was characterised floristically and then ethnobotanical indices (Ip and VU) were calculated to determine the plants of interest. To describe harvesting practices, the farmer's daily activities were monitored. 85 plant species were mentioned in 867 citations for three main uses: food (47.40%), medicinal (21.34%) and services (31.26%). Nineteen species were sought for food use, including *Panda oleosa* (17.57%), *Gnetum africanum* (13.86%), *Afrotyrax lepidophyllus* (13.62%) and *Irvingia gabonensis* (9.24%). Sixty-two species have been recorded as medicinal plants. *Alstonia boonei* (28 citations) is the most popular medicinal species in Gribé for treating infectious and parasitic diseases. Nineteen species were identified as service plants, with *Marantochloa cordifolia* (45 citations) being the most popular. Trees from dense forests with very little disturbance (72.94%) account for 65% of species. *Schumanniophyton magnificum* (Ip = 3) is highly effective against dysentery; *Aframomum daniellii* (Ip = 3) against Gonorrhoea, *Afrostyrax lepidophyllus* (Ip = 3) against kidney disease and *Alstonia boonei* (Ip = 2) against malaria. *Entandrophragma cylindricum* (VU = 1.25), *Massularia acuminata* (VU = 1.13), *Panda oleosa* (VU = 1.03) and *Gnetum africanum* (VU = 1.00) are also species of interest. Barks (43.24%) and fruits (33.76%), which are highly available, are the most sought-after organs. Stripping the bark (1.91%), debark-

ing the tree (19.48%) and collecting the fruit (31.35%) are the main harvesting techniques.

Keywords

Baka from Gribé, Ethnobotanical Indices, NTFPs, Sampling Techniques, Species of Special Interest

1. Introduction

The forests of Central Africa, more than half of which make up the Congo Basin, constitute the second largest area of dense tropical rainforest in the world after the Amazon [1]. These forests, and Cameroon's forests in particular, are home to an exceptional biological diversity on a global scale [2]. Cameroon's forests have an important economic function, both nationally and internationally, in addition to many other complementary functions. For rural populations, the forest plays not only an economic role, but also a social and cultural one [3]. As well as wood, the main timber resource exploited in the forest, the undergrowth hides real treasures that have long been ignored or neglected: non-timber forest products (NTFPs). Many rural people depend on NTFPs for their livelihood and source of income.

Although the January 1994 forestry law in Cameroon does not specifically take NTFPs into account in Cameroon, their exploitation for economic purposes is already taking place. It has intensified since 2000, with more than 1.044.82 tonnes of leaves, bark, seeds and roots being harvested annually [4]. Non-timber forest products (NTFPs) provide emergency food during lean periods, or constitute an emergency food safety net against seasonal hazards and in cases of need for households [5]. NTFPs play a key role in improving the living conditions of local and riparian populations in the hinterland. They provide basic necessities for subsistence and some make a relative contribution to the household economy through the income generated by their marketing [6]. These products complement household food production and provide essential nutritional and medicinal products. The current value of NTFPs to conservationists, foresters, development stakeholders and indigenous populations has prompted numerous initiatives aimed at promoting the sustainable use and marketing of NTFPs as a means of improving the well-being of rural populations, while at the same time conserving existing forests [7].

Although Cameroon's forestry law is currently being revised to regularise the use of NTFPs and place them on the legislative agenda, the initiatives undertaken are rarely of the following types related to the use of scientific techniques to determine the availability of these products around areas where communities settle ("forest villages") and near conservation areas. It is important to know the availability of resources to better manage and value them [8].

Considerable indigenous knowledge of certain non-timber forest products does

exist [7]. However, rigorous resource assessment of some NTFPs, particularly in tropical countries, is relatively new and has received little attention to date [7]. The multitude and variability of NTFPs, the multiplicity of interests and disciplines involved in NTFP assessment, financial and Institutional constraints, and the lack of terminology and universal units of measurement make it difficult to access the NTFPs and their resources [9].

NTFPs include foodstuffs, fodder plants, medicinal plants, edible plants, construction materials, craft products and exudates [10]. The exploitation of NTFPs does not receive the same attention as timber in terms of its profitability, regulation and valuation; yet these products are a permanent source of basic goods and income for local and riparian populations. According to [11], the relationship between the forest peoples of Central Africa (Pygmies and Bantu) and forest ecosystems is mystical and an integral part of their culture. Local people have empirical knowledge of the importance, availability, distribution, regeneration and seasonality of the resources they use on a daily basis. However, it has to be realised that these populations are often harmed and their knowledge is rarely considered in investigations that aim to at enhance biodiversity.

The "Baka" communities and the "Pygmy" people of the forests of eastern Cameroon should therefore be involved in analysing the productivity and the NTFP potential of the forests, and in developing strategies to respond to various constraints at both the national and regional levels. Work on NTFPs in Cameroon is carried out by locality and concerns the development of resource uses. More recent work has focused on the socio-economic aspects of these resources; however, very little work has been done on the management of these resources, which are not inexhaustible [12]. By drawing on the knowledge of the "Baka" communities of Gribé, this study is part of an approach to the sustainable management of the non-timber forest products (NTFPs) exploited by the populations of this community.

The general objective is to make an inventory of the NTFPs used by the Baka community of Gribé, and specifically to:

1) Characterise the uses of NTFPs by the Baka community of Gribé;

2) Highlight, through ethnobotanical indices, the species most in demand in the Baka community of Gribé;

3) Describe some harvesting practices for useful plants by the Baka of Gribé.

2. Materials and Methods

2.1. Presentation of the Study Area

The study took place in the village of Gribé, in the district of Yokadouma in the Boumba and Ngoko Division (East Cameroon Region). The village is located at coordinates 03˚00'10" north latitude and 14˚49'25" east longitude (**Figure 1**).

Gribé as a whole is subject to a Guinean-type equatorial climate, with an average annual temperature of 24˚C and average annual rainfall of up to 145.75 mm. The soils in the village of Gribé are ferralitic [13]. Gribé is part of the semi-caducifolia

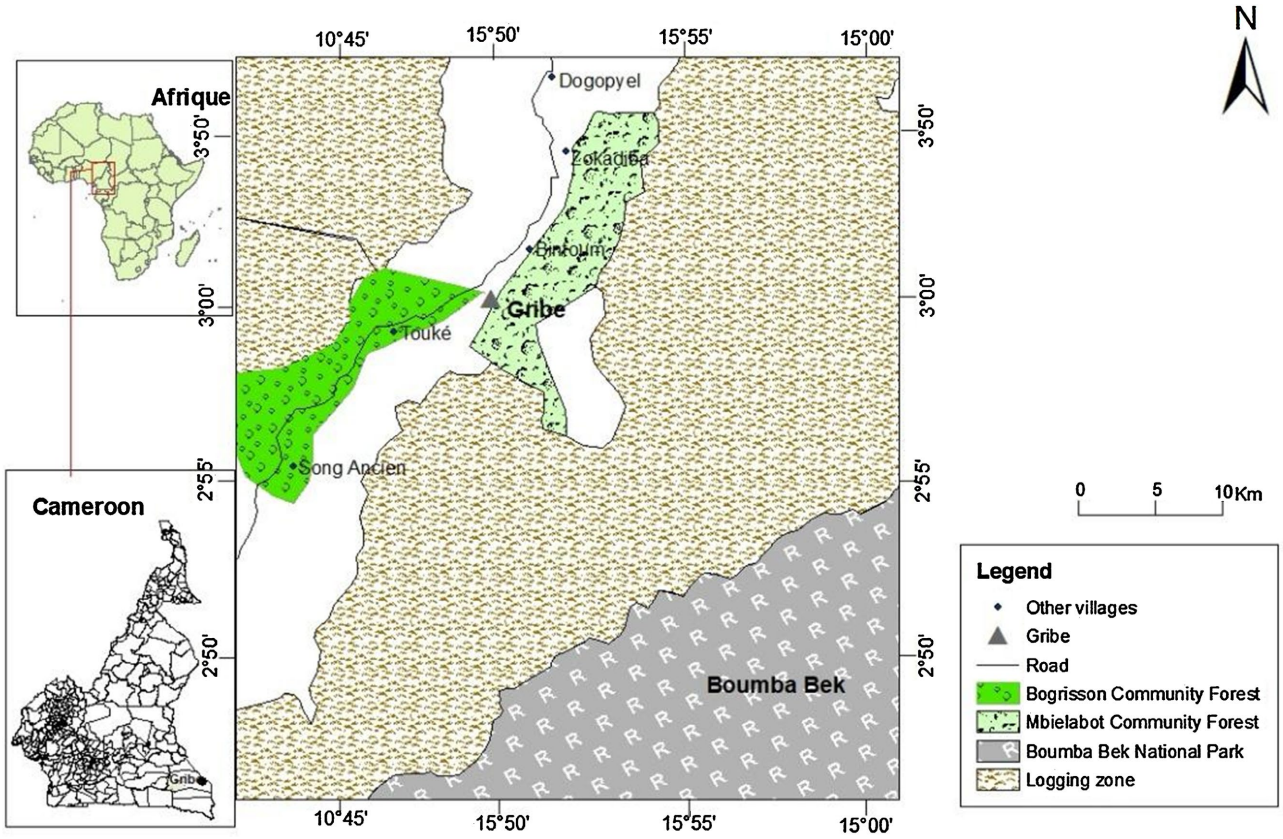


Figure 1. Location map of Gribé village.

rainforest [14]. The main wildlife species found in the vicinity of the village of Gribé are blue duiker (*Cephalophus callipygus*, *C. dorsalis*, *C. leucogaster* and *C. nigrifrons*), yellow-backed duiker (*C. silvicultor*) and wild boar (*Potamochoerus porcus*). Smaller animals, such as blue duiker (*C. monticola*) and porcupines (*Atherurus africanus*), are also hunted [15].

Two ethnic groups live together in the Gribé village: the Baka (around 94 households with a total of 400 people) and the Konabembé (around 74 households with a total of 300 people) [16]. For the most part, they make their living from farming, hunting, gathering, petty trading, small-scale livestock farming and fishing [17] [18]. However, logging continues to play a key role and influence the socio-economic context, as Gribé has 15 forest management units divided between 10 logging companies covering a total area of 823.982 hectares. Moreover, access to NTFPs is almost unrestricted.

2.2. Floristic Survey and Florula Characterisation

The method used for data collection was the ethnobotanical survey method through two activities: semi-structured interviews with Baka households and household monitoring.

2.2.1. Ethnobotanical Surveys

Information and awareness-raising meetings were held in the Baka communities

to obtain the consent of those concerned, and information was collected from anyone who voluntarily agreed to take part in the interviews. The people targeted by the interviews were adults and elderly people of both sexes who could provide reliable information on the use of wild plants. Semi-structured interviews per [19]-[21] were used to gather information on useful plants and to collect some of it. The information collected was based on a standardised framework, inspired by the form proposed by Betti for the UVACO-PFNL 2019 project, and specifically concerned: the identity of the informant, the categories of use, the characteristics of the plant material used for each recipe and the instructions for use of the organs. Information on organ availability and other uses was also collected (**Figure 2**).

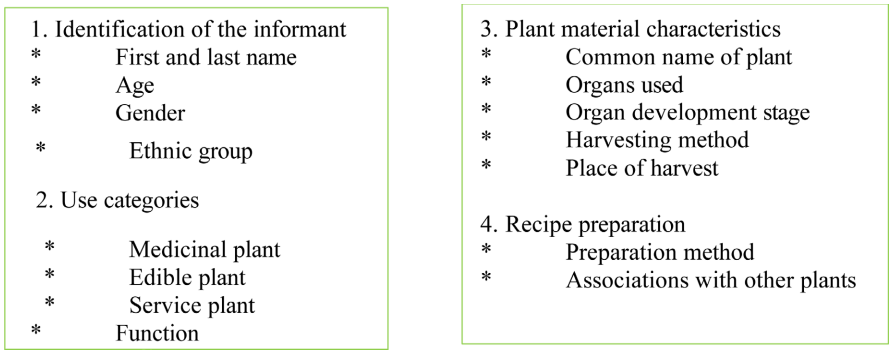


Figure 2. Different sections of the interview guide.

An interview guide was chosen by the canton chief to facilitate discussions with the local population and to accompany them on site when samples were collected. Information on medical use was collected using a standardised format based on the Pharmel sheets [22]. For each therapeutic indication, details of the recipe were carefully recorded and, wherever possible, the treating plant was sought out, seen, filmed and harvested [23] [24]. In the case of food plants, details were sought as to whether they could be used as a main dish, vegetable, spice or condiment, snack or drink [20].

2.2.2. Specimen Collection and Identification

Specimens were collected "*in situ*", firstly by taking photos of them with a digital camera and then by removing the organs of interest from the plant. A reference herbarium was compiled in order to reconstruct the florae of the plants inventoried at Gribé. The plants thus collected were identified firstly by transposing the vernacular names into commercial names for certain species; then using the floristic works [14] [23] [25]-[27], the online databases https://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php; https://uses.plantnetproject.org/en/, specialised websites (Protau4.org) and other data available from the National Herbarium of Cameroon (the vascular plants of Cameroon—A taxonomic checklist with IUCN assessments; compendium of plant names in the ethnic languages of Cameroon). This identification was confirmed by botanists at the National Herbarium of Cameroon. Samples were identified to family, genus and,

where possible, species level according to APG IV.

2.2.3. Characterisation of the Surveyed Plant Florula at Gribé

The plant species thus identified were classified by biological type [28] [29], morphological type, phytogeographical type [30]-[32], habitat type [20] and type and mode of spread of diaspores [20] [33]-[35].

2.3. Determination of the Species Mostly in Demand

2.3.1. Processing of Data

The data collected was analysed, then recorded and processed according to the number of quotations and recipes. Each survey sheet contained a single item of information called a "quotation", which corresponded to a line in the Excel version 213 spreadsheet and included all the information collected from an informant [20] [23] [36]. All the information collected was analysed using the aforementioned spreadsheet, which was then used to calculate frequencies as a percentage of quotations and to generate histograms. Ethnobotanical indices were also calculated.

2.3.2. Calculation of Ethnobotanical Indices

- Ethnobotanical use value (EUV)

The EUV is used to determine which species have a high use value in a given environment. It was used to establish a hierarchy of importance for NTFP source species based on the formula used by [37]:

$$VU(k) = \frac{\sum_i^n Si}{n}$$

with:

$VU(k)$: Ethnobotanical use value of a species k within a given use category;

Si: use score assigned by respondent i;

n: Number of respondents for the given use category. The use value of a given species (k), within a given use category, is defined by its average use score within this use category.

- Performance index (PI)

The performance index (PI) is used to highlight the most significant uses of a recipe for treating a disease. In the comparison between the florula (small flora) indicated to treat a given disease and the overall medicinal flora, the hypothesis tested (null hypothesis in the statistical sense) is that for a given therapeutic indication (disease), the list of plants cited for its treatment results from a random draw from the medicinal flora. (C1) was considered as the number of citations of the plant for a specific disease, (C2) as the total number of citations of the plant for all diseases, (C3) as the number of citations of a specific disease for all species, (C4) as the total number of citations, (P1) = C1/C2: the observed proportion, (P2) = C3/C4: the theoretical proportion as well as the performance index (PI). The proportions (for the species) measured for the medicinal flora are considered as theoretical proportions (P2%) and compared with those observed for the flowering plant cited against the chosen disease (P1%). The difference observed between

these two proportions (D = P1 − P2) indicates whether or not the sample analysed is a random sample of the medicinal flora; the direction of the difference makes it possible to decide whether the group studied is preferred (D > 0) or rejected (D < 0). The proportions used here are ratios of the number of citations [20] [23]. For example, if P1% of citations of a species are collected as antimalarials, P1 is compared with P2%, the percentage of all citations of this species present in the medicinal flora. This shows whether the species studied is statistically preferred or rejected in the flora cited for its use as an antimalarial. Taking D = 0 as the minimum performance threshold for a species and 1 as the maximum value, a performance index (Ip) is proposed using an arbitrary scale ranging from 0 to 3 such that:

Ip = 0, if D < 0: Zero performance;

Ip = 1, if 0 ≤ D < 1/3: Average performance;

Ip = 2, if 1/3 ≤ D < 2/3: High performance;

Ip = 3, if D ≥ 2/3: Very high performance.

2.4. Monitoring Households in Their Harvesting Activities

The farmer was followed in his daily activity around the village or in the forest to describe the practices of harvesting plant organs. This practice was characterised by photographs and a description of the harvesting technique by the farmer. Two main harvesting methods were selected [38] [39]. These were gathering and picking. These methods are sometimes combined for certain organs such as fruit. When, for this heading, the same informant mentioned either picking or collecting, the information was noted as picking/collecting. Picking involves cutting the stem, scraping, debarking and piercing the tree. Individuals whose plant organs are picked will be traumatised and therefore more vulnerable than those whose parts fall to the ground. Trees that have been completely felled are more vulnerable than those that have been partially limbed.

3. Results

3.1. Socio-Demographic Profile of Respondents

This survey included 76 of 168 households (45.23%), with a total of 178 informants participating in interviews. Of these respondents, 117 (65.74%) were men. Three age groups, including young people [20 - 40], adults [40 - 60] and the elderly [60 - 85], were defined to determine the age of respondents in the households. The results show that the elderly (81, 45.50%) are among the most represented informants, followed by (69, 38.76%) and 15.73% young people. The majority of informants in Gribé are Baka (149 Baka informants compared with 29 Konabembé informants). Four major activities, including gathering and/or collecting (77 informants, *i.e.* 43.25%), agriculture (58 informants, *i.e.* 32.58%), traditional medicine (29 informants, *i.e.* 16.29%) and hunting (7.88%), occupy the daily lives of these informants. However, in 71.00% of cases, the informants in the Gribé village practised at least 2 of the 4 activities.

3.2. Different Uses of NTFPs in Gribé

Plants are used in Gribé for three main purposes: food, medicine and services. A total of 85 plant species were mentioned in 867 citations for these different uses. Figure 3 illustrates the proportions of plants listed by use category and frequency of mention. Medicinal plants (62) are the most important in terms of number of species (60.19%) but the least important in terms of number of citations (21.34%).

3.2.1. Edible Plants

Nineteen wild plant species were identified as being consumed by Baka households. These were used to prepare 23 culinary recipes for 401 citations. The edible uses to which these are put and the organs used for these uses (Table 1). Analysis of this table shows that the edible plants consumed by the Baka of Gribé are used in six ways, of which snacks (10 plant species mentioned in 177 citations) and condiments/spices (5 plant species for 170 citations) are the most frequently mentioned. The fruits of 14 of the species mentioned 313 times by the informants are

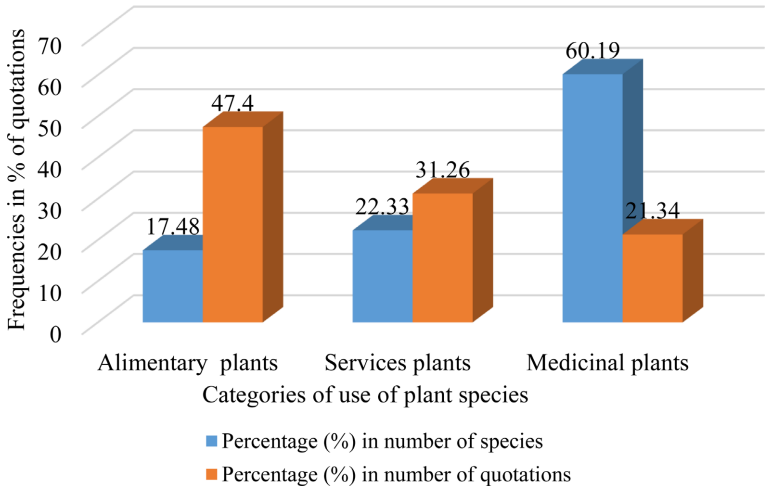


Figure 3. NTFP use categories at Gribé.

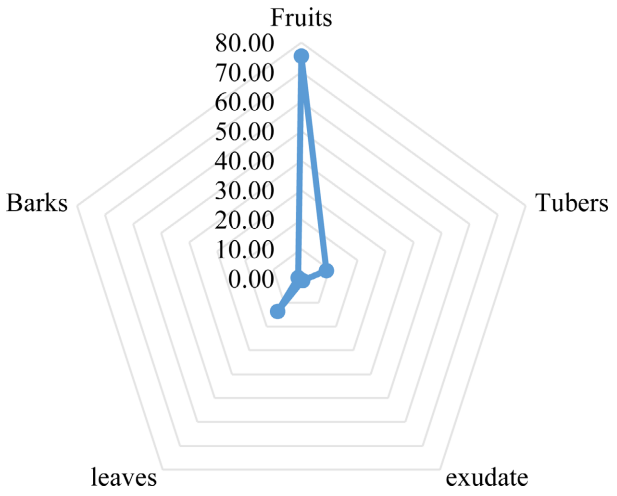


Figure 4. Organs used to make recipes based on edible plants.

Table 1. Edible plants surveyed in Gribé.

Scientific names	Names ver/com	Families	Edible uses					Requested parties					Floristic characteristics					Nq
			ap	sp	md	dk	veg	fr	tu	ex	le	bk	BT	TBI	PT	DT	MD	
Afrostyrax lepidophyllus Mildbr.	Guimba (grand)	Huaceae		×				×					Tr	Pf	Gc	Sar	Zoo	56
Anonidium mannii (Oliv.) Engl. & Diels	Mgbé/ Ebom	Annonaceae	×					×					Tr	Pf	Gc	Sar	Zoo	41
Baillonella toxisperma Pierre	Mabé	Sapotaceae	×					×					Tr	Pf	Gc	Sar	Zoo	33
Chrysophyllum lacourtianum De Wild.	Abam	Sapotaceae	×					×					Tr	Pf	Gc	Sar	Zoo	3
Chytranthus atroviolaceus Baker f. ex Hutch.	Tokomboli	Sapindaceae	×					×					Sb	Pf	Sz	Sar	Zoo	2
Cola acuminata (P. Beau.) Schott & Endl.	Mbanga	Sterculiaceae	×					×					Tr	Pf	Gc	Sar	Zoo	3
Dioscorea burkilhana J. Miège	Kéké	Dioscoreaceae			×				×				Li	Fal	Pan	Pte	Ane	14
Dioscorea cayenensis Lam.	Igname jaune	Dioscoreaceae			×				×				Li	Fal	Am	Pte	Ane	13
Garcinia kola Heckel	Cola	Clusiaceae	×					×					Tr	Pf	Wg	Sar	Ane	3
Gnetum africanum Welw.	Koko	Gnetaceae					×				×		Li	Pf	Gc	Scle	Ane	57
Irvingia excelsa Mildbr.	Payo	Irvingiaceae	×					×					Tr	Pf	Gc	Sar	Zoo	2
Irvingia gabonensis (Aub. Lec. ex O'R) Bail.	Pféké	Irvingiaceae	×	×	×			×					Tr	Pf	Gc	Sar	Zoo	38
Panda oleosa Pierre	Kana/ Afana	Pandaceae		×				×					Sb	Pf	Gc	Sar	Zoo	72
Raphia regalis Becc.	Kpwa djambo,	Arecaceae				×				×			Ssb	Hyf	Gc	Sar	Zoo	3
Scorodophloeus zenkeri Harms	Mingaignai /Olom	Fabaceae			×							×	Tr	Pf	At	Sar	Zoo	5
Trichoscypha acuminata Engl.	Ngoyo	Anacardiaceae	×					×					Tr	Pf	Gc	Sar	Zoo	37
Trichoscypha arborea (A. Chev.) A. Chev.	Amvout/ Boudeu	Anacardiaceae	×					×					Tr	Pf	Gc	Sar	Zoo	15
Vitex thyrsiflora Baker	Pko-ndombi	Lamiaceae		×				×					Li	Fp	Wg	Sar	Zoo	2
Ricinodendron heudelotii (Baill.) Pierre ex Heckel	Gobo/ Njangsang	Euphorbiaceae		×	×			×					Tr	Fp	Gc	Sar	Zoo	2

Key: ap = appetizers, sp = condiment/spice, md = maindish, dk = drink, oil = oil, veg = vegetable, fr = fruit, tu = tubers, ex = exudate, le = leaves, bk = bark, BT = Biological type (Tr = Tree, Ag = Annual grass, Pg = Perennial grass, Sb = Shrub, Li = Liana, Usb = Sub shrub), TBI = Type of biotope (Pf = Primary forest, Fal = Forest fallow, Hyf = Hydromorphous forest, Cul = Culture), PT = Phytogeographic type (Gc = Guineo-Congolese Central, Am = Afro-Malgache, Wg = Western Guinean, Sz = Sudanese-Zambesian), DT = Diaspora type (Sar = Sacochore, Pte = Pterochore, Scle = Sclerochore), MD = Modes of dissemination of diaspores (Zoo = zoochory, Ane = anemochory), Nq = Number of quotes.

the organs most often used to prepare the recipes cited by the Gribé informants. Leaves and tubers accounted for 13.73% and 8.82% respectively (Figure 4). *Panda oleosa* (Pandaceae), was frequently cited (17.57%), followed by *Gnetum Africanum* (13.86%), *Afrotyrax lepidophyllus* (13.62%), *Irvingia gabonensis* (9.24%) and *Tri-*

choscypha acuminata (9.00%). All these species belong to 15 families, including Anacardiaceae, Dioscoreaceae, Irvingiaceae and Sapotaceae with two species each (Table 1).

3.2.2. Medicinal Plants

Sixty-two plant species have been identified as medicinal plants. They belong to 32 families, the most represented of which are Euphorbiaceae, Fabaceae, Annonaceae, Moraceae, Rubiaceae, Apocynaceae and Zingiberaceae, with 8, 6, 5, 4, 4, 3 and 3 species each respectively. Of the plants cited as medicinal plants in Gribé households, some are only used as associated plants in recipes. *Elaeis guineensis* Jacq. and *Capsicum frutescens* L., mentioned 16 and 17 times respectively, are used exclusively as secondary plants in the preparation of medicinal recipes. *Alstonia boonei* (28 citations) is the most popular cited medicinal species in Gribé, followed by *Greenwayodendron suaveolens* (Engl. & Diels) Verdc. (19 mentions), *Tetrapleura tetraptera* (Schum. & Thonn.) Taub. (9 mentions), *Pycnanthus angolensis* (Welw.) Warb. (8 mentions), *Entandrophragma cylindricum* (Sprague) Sprague (6 mentions) and *Diospyros crassiflora* Hiern. (5 mentions). The surveyed medicinal plants in Gribé are used to treat sixteen illnesses or therapeutic indications, of which malaria (21.62%), diarrhoea (11.89%) and kidney ailments (11.35%) are the most frequently cited (Figure 5). In addition, the diseases treated by plants mentioned by the Gribé people fall into eight main disease groups, including the group of infectious and parasitic diseases (M.inf.par.) (28 plants), the group of sensitivities, symptoms and ill-defined states (Sén.sym.m.d.) (27 plants), Diseases of the genital-urinary organs (M.org.gé-uri.) (19 plants requested) and Diseases of the digestive system (M.ap.dig.) (10 plants requested) are the most important (Table 2).

Treated diseases or therapeutic indications

Nineteen illnesses or therapeutic indications emerged from the surveys of Baka households in Gribé. The diseases are illustrated in Figure 5, which shows the compartment occupied by each disease. Malaria (20.63%), kidney ache (13.76%), headache (11.64%), stomachache (10.58%) and dysentery (10.05%) occupy the most important compartments. Gonorrhoea, respiratory problems and gastric ulcers (0.53% each) occupied the smallest compartments (Figure 5).

Plant organs of medicinal plants

The organs used to prepare plant-based medicines are bark, leaves, fruit, roots and exudates. Of these organs, bark is the most frequently used, accounting for 62.85% (Figure 6). Leaves and fruits represented 17.14% and 15.23% respectively. The barks of *Alstonia boonei* were cited 28 times, those of *Pycnanthus angolensis* 08 times, while the fruits of *Elaeis guineensis* and *Capsicum frutescens* were cited 19 and 11 times respectively by the Baka of Gribé (Table 2).

Pharmaceutical forms and routes of administration

To prepare phytomedicines, the Baka of Gribé uses seven pharmaceutical forms: decoction, maceration, ash, juice, raw organ, powder and ointment. Decoctions are the most used forms (43.00% of recipes), followed by macerations and ashes,

Table 2. Medicinal plants surveyed in the Gribé community.

Scientific names	Names ver/com	Families	Major disease groups								Requested parties					Floristic characteristics					Nq
			Drs	Dds	Ipd	Dnss	Dgo	Dbn	Ses	Dsct	fr	tu	ex	le	bk	BT	TBI	PT	DT	MD	
Aframomum daniellii (Hook. f.)	Ndiyi	Zingiberaceae			×				×		×					Pg	Pf	Gc	Sar	Zoo	4
Aframomum melegueta (Roescoe) K. Schum.	Mbongo, Ndong/ Tondo	Zingiberaceae				×					×					Pg	Pf	Gc	Sar	Zoo	1
Afrostyrax lepidophyllus Mildbr.	Guimba	Huaceae			×		×		×						×	Sb	Pf	Gc	Sar	Zoo	3
Albizia zygia (DC.) J. F. Macbr.	Bamba	Fabaceae					×								×	Tr	Pf	Gc	Bar	Aut	1
Alstonia boonei De Wild.	Gouga/ Emien	Apocynaceae			×				×	×					×	Tr	Fs	Gc	Pog	Ane	28
Amphimas pterocarpoides Harms	Ekéla/ Kanga	Fabaceae				×								×	×	Tr	Pf	Gc	Pte	Ane	2
Angylocalyx vermeulenii De Wild.	Yonga	Fabaceae			×									×		Sb	Pf	Gc	Sar	Zoo	2
Annickia affinis (Exell) Versteegh & Sosef	Epouhé	Annonaceae			×		×								×	Tr	Pf	Gc	Sar	Zoo	3
Anonidium mannii (Oliv.) Engl.	Mgbé/ Ebom	Annonaceae					×								×	Tr	Pf	Gc	Sar	Zoo	1
Anopyxis klaineana (Pierre) En.	Booma	Rhizophoraceae					×								×	Tr	Pf	Gc	Sar	Zoo	1
Campylospermum elongatum (Oliv.) Tiegh.	Djalla	Ochnaceae					×									Tr	Pf	Gc	Sar	Zoo	1
Capsicum frutescens L.	Alambanatolo	Solanaceae							×		×					Ssb	Cul	Pan	Sar	Zoo	1 + 10
Celtis mildbraedii Engl.	Ngombé	Cannabaceae			×										×	Tr	Pf	Gc	Sar	Zoo	1
Chrysophyllum lacourtianum De Wild.	Bamboo/ Koloka	Sapotaceae		×									×			Tr	Pf	Wg	Sar	Zoo	1
Corynanthe pachyceras K. Schum.	Mocha/ Wassassa	Rubiaceae			×				×						×	Tr	Pf	Gc	Scle	**Ane**	3
Croton oligandrus Pierre ex Hutch.	Dengo	Euphorbiaceae			×				×						×	Tr	Fs	Gc	Sar	Zoo	2

Key: Drs (D.rsp.sys.) = Diseases of the respiratory system, Dds (D.dig.sys.) = Diseases of the digestive system, Ipd (Inf.par.D.) = Infectious and parasitic diseases, Dnss (D.ner.sys.s.org.) = Diseases of the nervous system and sense organs, Dgo (D.ge-uri.org.) = Diseases of the genital-urinary organs, Dbn (D.bn.sf.org.) = Diseases of the bones and soft organs, Ses (Sen.sym.ill.d.) = Sensitivity, symptoms and ill-defined states, Dsct (D.s.cc.t.) = Diseases of skin and cellular tissue, fr = fruit, tu = tubers, ex = exudate, le = leaf, bk = bark, BT = Biological type (Tr = Tree, Ag = Annual grass, Pg = Perennial grass, Sb = Shrub, Li = Liana, Ssb = Sub shrub),TBI = Type of biotope (Pf = Primary forest, Fs = Secondary forest, Fal = Forest fallow, Hyf = Hydromorphous forest, Cul = Culture), PT = Phytogeographic type (Gc = Guineo-Congolese Central, Am = Afro-Malgache, Wg = Western Guinean, Pan = Pan-tropical), DT = Diaspora type (Sar = Sacochore, Pte = Pterochore, Bar = Barochore, Pog = Pogonochore), MD = Modes of dissemination of diaspores (Zoo = Zoochory, Ane = Anemochory, Aut = Autochory), Nq = Number of quotes.

Continued

Scientific names	Names ver/com	Families	Major disease groups							Requested parties						Floristic characteristics					Nq
			Drs	Dds	Ipd	Dnss	Dgo	Dbn	Ses	Dsct	fr	tu	ex	le	bk	ro	BT	TBI	PT	DT	MD	
Cylicodiscus gabunensis Harms	Bolouma	Fabaceae			×				×						×		Tr	Pf	Gc	Bar	Aut	3 + 1
Cymbopogon citratus (DC.) Stapf	Meniang	Zingiberaceae							×					×			Pg	Cul	Pan	Scle	Ane	0 + 2
Diospyros crassiflora Hiern	Lembè	Ebenaceae		×	×		×		×						×		Tr	Pf	Gc	Sar	Zoo	5
Discoglypremna caloneura (Pax) Prain	Djilla	Euphorbiaceae					×									×	Tr	Pf	Gc	Sar	Zoo	1
Drypetes gossweileri S.Moore	Gbologa	Euphorbiaceae					×		×					×	×		Tr	Pf	Wg	Sar	Zoo	3
Duboscia macrocarpa Bocq.	Goulouma	Malvaceae			×										×		Tr	Pf	Gc	Sar	Zoo	1
Duguetia staudtii (Engl.& Diels) Chatrou	Molombo	Annonaceae			×				×						×		Tr	Pf	Gc	Sar	Zoo	2
Elaeis guineensis Jacq.	Mbila	Arecaceae							×		×						Ssb	Cul	Gc	Sar	Zoo	0 + 16
Elaeophorbia drupifera (Thonn.)Stapf	Songolibila	Euphorbiaceae		×										×			Tr	Pf	At	Sar	Zoo	1
Entandrophragma cylindricum (Sprague)Sprague	Boyo	Meliaceae			×		×		×						×		Tr	Pf	Gc	Pte	Ane	5 + 1
Eremomastax speciosa (Hochst.)Cufod.	Twosides	Acanthaceae			×					×				×			Ag	Rud	At	Scle	Ane	3
Ficus pseudomangifera Hutch.	Bongo	Moraceae							×						×		Li	Fs	Gc	Sar	Zoo	1
Greenwayodendron suaveolens (Engl.&Diels)Verdc.	Gbotunga	Annonaceae			×				×					×	×	×	Tr	Pf	Gc	Sar	Zoo	19
Hunteria umbellate (K. Schum.) Hallier f	Modanga	Apocynaceae		×			×								×		Tr	Pf	Gc	Sar	Zoo	4
Irvingia gabonensis	Pféké	Irvingiaceae			×										×		Tr	Pf	Gc	Sar	Zoo	1

Key: Drs (D.rsp.sys.) = Diseases of the respiratory system, Dds (D.dig.sys.) = Diseases of the digestive system, Ipd (Inf.par.D.) = Infectious and parasitic diseases, Dnss (D.ner.sys.s.org.) = Diseases of the nervous system and sense organs, Dgo (D.ge-uri.org.) = Diseases of the genital-urinary organs, Dbn (D.bn.sf.org.) = Diseases of the bones and soft organs, Ses (Sen.sym.ill.d.) = Sensitivity, symptoms and ill-defined states, Dsct (D.s.cc.t.) = Diseases of skin and cellular tissue, fr = fruit, tu = tubers, ex = exudate, le = leaf, bk = bark, BT = Biological type (Tr = Tree, Ag = Annual grass, Pg = Perennial grass, Sb = Shrub, Li = Liana, Ssb = Sub shrub), TBI = Type of biotope (Pf = Primary forest, Fs = Secondary forest, Fal = Forest fallow, Hyf = Hydromorphous forest, Cul = Culture), PT = Phytogeographic type (Gc = Guineo-Congolese Central, Am = Afro-Malgache, Wg = Western Guinean, Pan = Pan-tropical), DT = Diaspora type (Sar = Sacochore, Pte = Pterochore, Bar = Barochore, Pog = Pogonochore), MD = Modes of dissemination of diaspores (Zoo = Zoochory, Ane = Anemochory, Aut = Autochory), Nq = Number of quotes.

Continued

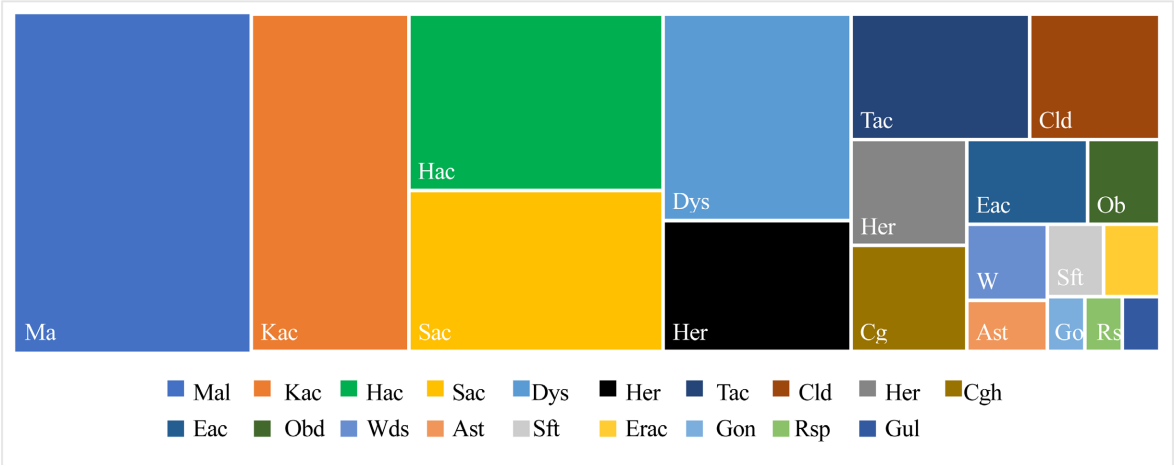
Scientific names	Names ver/com	Families	Major disease groups								Requested parties					Floristic characteristics					Nq
			Drs	Dds	Ipd	Dnss	Dgo	Dbn	Ses	Dsct	fr	tu	ex	le	bk	BT	TBI	PT	DT	MD	
Klainedoxa gabonensis Pierre ex Engl.	Bokoko	Irvingiaceae			×										×	Tr	Pf	Gc	Sar	Zoo	1
Macaranga monandra Müll. Arg.	Moussassa	Euphorbiaceae			×									×		Tr	Pf	Gc	Scle	Ane	1
Maesopsis eminii Engl.	Londo	Rhamnaceae			×		×								×	Tr	Fs	Gc	Sar	Zoo	2
Manniophyton fulvum Mull. Arg.	Kpwo koussa	Euphorbiaceae			×				×					×		Li	Fs	Gc	Bar	Aut	3
Maranthochloa purpurea (Ridley) Milne-Redh.	Boboko/Pondo Gouassa,	Marantaceae			×				×					×		Pg	Pf	Gc	Sar	Zoo	2
Massularia acuminata (G. Don) Bullock ex Hoyle	Mindo	Rubiaceae	×				×				×				×	Sb	Pf	Gc	Sar	Zoo	3 + 1
Microdesmis puberula Hook. f. ex. Planch	Pfipfi	Pandaceae						×	×					×	×	Sb	Pf	Gc	Sar	Zoo	2
Milicia excelsa (Welw.) Berg	Bangui	Moraceae							×	×					×	Tr	Fs	Gc	Sar	Zoo	2
Millettia sanagana Harms	Nganda	Fabaceae				×			×					×	×	Tr	Pf	Wg	Bar	Aut	2
Mitragyna ledermannii (K. Krause) Ridsdale	Langango/ Mouèssè	Rubiaceae		×											×	Tr	Hyf	Gc	Sar	Zoo	1
Monodora crispata Engl. & Diels	Djingo	Annonaceae			×		×		×						×	Sb	Pf	Gc	Sar	Zoo	3
Musanga cecropioides R. Br.	Kombo	Moraceae					×								×	Tr	Fs	Gc	Sar	Zoo	1
Myrianthus arboreus P. Beauv.	Ngatta	Moraceae		×										×		Tr	Fs	Gc	Sar	Zoo	1
Nephrolepis biserrata (SW.) Schott	cobo (fougère)	Dryopteridaceae							×					×		Pg	Fs	At	Scle	Ane	1
Omphalocarpum elatum Miers.	Mbaté	Sapotaceae							×						×	Tr	Pf	Gc	Sar	Zoo	1
Panda oleosa Pierre	Kana/ Afana	Pandaceae		×	×		×				×				×	Sb	Pf	Gc	Sar	Zoo	3

Key: Drs (D.rsp.sys.) = Diseases of the respiratory system, Dds (D.dig.sys.) = Diseases of the digestive system, Ipd (Inf.par.D.) = Infectious and parasitic diseases, Dnss (D.ner.sys.s.org.) = Diseases of the nervous system and sense organs, Dgo (D.ge-uri.org.) = Diseases of the genital-urinary organs, Dbn (D.bn.sf.org.) = Diseases of the bones and soft organs, Ses (Sen.sym.ill.d.) = Sensitivity, symptoms and ill-defined states, Dsct (D.s.cc.t.) = Diseases of skin and cellular tissue, fr = fruit, tu = tubers, ex = exudate, le = leaf, bk = bark, BT = Biological type (Tr = Tree, Ag = Annual grass, Pg = Perennial grass, Sb = Shrub, Li = Liana, Ssb = Sub shrub),TBI = Type of biotope (Pf = Primary forest, Fs = Secondary forest, Fal = Forest fallow, Hyf = Hydromorphous forest, Cul = Culture), PT = Phytogeographic type (Gc = Guineo-Congolese Central, Am = Afro-Malgache, Wg = Western Guinean, Pan = Pan-tropical), DT = Diaspora type (Sar = Sacochore, Pte = Pterochore, Bar = Barochore, Pog = Pogonochore), MD = Modes of dissemination of diaspores (Zoo = Zoochory, Ane = Anemochory, Aut = Autochory), Nq = Number of quotes.

Continued

Scientificnames	Names ver/com	Families	Major disease groups								Requested parties						Floristic characteristics					Nq
			Drs	Dds	Ipd	Dnss	Dgo	Dbn	Ses	Dsct	fr	tu	ex	le	bk	ro	BT	TBI	PT	DT	MD	
Penianthus longifolius Miers		Menispermaceae		×											×	×	Ssb	Pf	Gc	Sar	Zoo	2
Picralima nitida (Stapf) T. Durand & H. Durand	Motokotoko	Apocynaceae					×								×		Tr	Fs	Gsz	Sar	Zoo	2
Plagiostyles africana (Müll. Arg.) Prain	Ngolé	Euphorbiaceae			×										×		Tr	Fs	Gc	Sar	Zoo	1
Pycnanthus angolensis (Welw.) Warb.	Etengué	Myristicaceae	×						×						×		Tr	Fs	Gc	Sar	Zoo	8
Ricinodendron heudelotii	Gobo	Euphorbiaceae			×										×		Tr	Pf	Gc	Sar	Zoo	1
Rinorea dentata (P. Beauv.) Kuntze	Sandjabongo	Violaceae							×						×		Sb	Pf	Gc	Sar	Zoo	1
Rourea obliquifoliolata Gilg.	Toukoussa	Connaraceae							×							×	Li	Pf	Gc	Sar	Zoo	1
Santiria trimera (Oliv.) Aubrév.	Libaba	Burseraceae			×										×		Tr	Pf	Gc	Sar	Zoo	1
Scepocarpus trinervis (Hochst.) T. Wells & A. K. Monro	Madjembè	Urticaceae				×									×		Li	Fs	Pal	Sar	Zoo	1
Schumanniophyton magnificum (K. Schum.) Harms	Gogologo	Rubiaceae				×									×		Sb	Fs	Gc	Sar	Zoo	1
Terminalia superba Engl. & Diels	Ngolou	Combretaceae		×	×										×		Tr	Pf	Gc	Pte	Ane	3
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	Djaga	Fabaceae					×			×				×	×	×	Tr	Pf	Gc	Bar	Aut	9
Thomandersia hensii De Wild. & T. Durand	Ngoka	Acanthaceae				×								×			Tr	Pf	Gc	Bar	Aut	1
Trichoscypha acuminata Engl.	Ngoyo	Anacardiaceae		×			×		×						×		Tr	Pf	Gc	Sar	Zoo	3
Zanthoxylum gilleti (De Wild.) Wattermani	Bolongo	Rutaceae			×									×	×		Tr	Pf	Gc	Sar	Zoo	2

Key: Drs (D.rsp.sys.) = Diseases of the respiratory system, Dds (D.dig.sys.) = Diseases of the digestive system, Ipd (Inf.par.D.) = Infectious and parasitic diseases, Dnss (D.ner.sys.s.org.) = Diseases of the nervous system and sense organs, Dgo (D.ge-uri.org.) = Diseases of the genital-urinary organs, Dbn (D.bn.sf.org.) = Diseases of the bones and soft organs, Ses (Sen.sym.ill.d.) = Sensitivity, symptoms and ill-defined states, Dsct (D.s.cc.t.) = Diseases of skin and cellular tissue, fr = fruit, tu = tubers, ex = exudate, le = leaf, bk = bark, BT = Biological type (Tr = tree, Ag = annual grass, Pg = perennial grass, Sb = shrub, Li = liana, Ssb = sub shrub),TBI = Type of biotope (Pf = Primary forest, Fs = Secondary forest, Fal = Forest fallow, Hyf = Hydromorphous forest, Cul = Culture), PT = Phytogeographic type (Gc = Guineo-Congolese Central, Am = Afro-Malgache, Wg = Western Guinean, Pan = Pan-tropical), DT = Diaspora type (Sar = Sacochore, Pte = Pterochore, Bar = Barochore, Pog = Pogonochore), MD = Modes of dissemination of diaspores (Zoo = Zoochory, Ane = Anemochory, Aut = Autochory), Nq = Number of quotes.



Key: Malaria(Mal), Kidneyache (Kac), Headache (Hac), Stomachache (Sac), Dysentery (Dys), Hernia (Her), Toothache (Tac), Cold (Cld), Hemorrhoids (Hem), Cough (Cgh), Eye ache (Eac), Obstetrical difficulties (Obd), Wounds (Wds), Asthenia (Ast), Swollen feet (Sft), Ear ache (Erac), Gonorrhea (Gon), Respiratory problems (Rsp), Gastric ulcer (Gul).

Figure 5. Proportion of diseases treated and therapeutic indications.

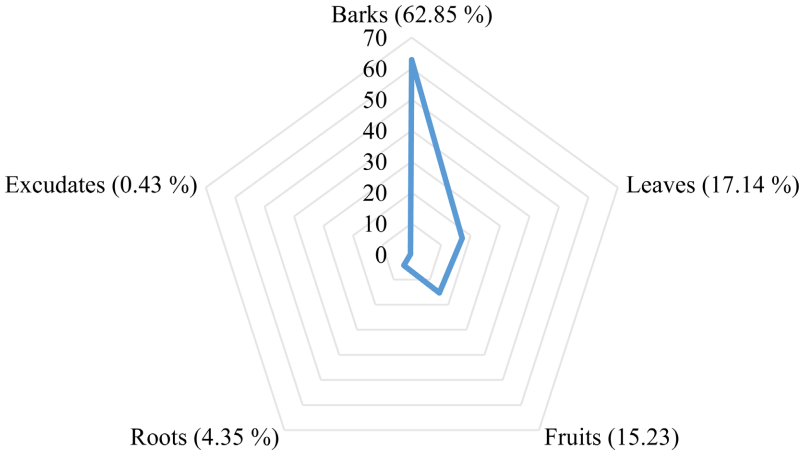


Figure 6. Proportion of plant parts used in recipes.

with 17.00% and 16.00% respectively.

Phytomedicines derived from the above pharmaceutical forms are administered orally (67.00% of citations), dermally (9.00%), rectally (8.00%), by scarification (intradermally) (7.00%), ocularly (4.00%) and nasally (3.00% of citations).

Plant performance according to the diseases treated

Plant performance was determined according to the diseases treated. However, only plants with high performance (Ip = 2) and very high performance (Ip = 3) were included in Table 3. Thus, of the 17 high-performance plants indicated against malaria, only 8 showed good performance (Ip = 2). *Santiria trimera* and *Schumanniophyton magnificum* performed very well (Ip = 3) against dysentery. *Chrysophyllum lacourtianum* and *Elaeophorbia drupifera* performed very well against toothache (Table 3).

Table 3. Plant performance according to diseases treated.

Diseases	Plants	Ip	Diseases	Plants	Ip
Malaria	*Alstonia boonei*	2	Toothache	*Chrysophyllum lacourtianum*	3
	Celtis mildbraedii	2		*Elaeophorbia drupifera*	3
	Entandrophragma cylindricum	2		*Mitragyna ledermannii*	2
	Irvingia gabonensis	2		*Panda oleosa*	2
	Monodora crispata	2		*Penianthus longifolius*	2
	Ricinodendron heudelotii	2		*Terminalia superba*	2
	Terminalia superba	2	Hernia	*Albizia zygia*	2
	Zanthoxylum gilleti	2		*Annickia affinis*	3
Soreeyes	*Aframomum melegueta*	2		*Hunteria umbellata*	2
	Amphimas pterocarpoides	2		*Maesopsis eminii*	2
	Scepocarpus trinervis	2		*Massularia acuminata*	2
	Thomandersia hensii	2		*Musanga cecropioides*	2
	Angylocalyx vermeulenii	2		*Picralima nitida*	2
Stomachache	*Croton oligandrus*	3	Hemorrhoids	*Anonidium mannii*	3
	Entandrophragma cylindricum	3		*Hunteria umbellata*	2
	Greenwayodendron suaveolens	2	Dysentery	*Angylocalyx vermeulenii*	2
	Maranthochloa purpurea	2		*Greenwayodendron suaveolens*	2
	Terminalia superba	2		*Klainedoxa gabonensis*	2
Headache	*Drypetes gossweileri*	2		*Maesopsis eminii*	2
	Milicia excelsa	2		*Manniophytom fulvum*	2
	Monodora crispata	3		*Maranthochloa purpurea*	2
	Rourea obliquifoliolata	3		*Plagiostyles africana*	3
Kidney pain	*Afrostyrax lepidophyllus*	3		*Santiria trimera*	3
	Anopyxis klaineana	3		*Schumanniophyton magnificum*	3
	Campylospermum elongatum	3	Asthenia	*Corynanthe pachyceras*	2
	Diospyros crassiflora	2		*Rinorea dentata*	2
	Drypetes gossweileri	2	Gonorrhea	*Aframomum daniellii*	3
	Entandrophragma cylindricum	2		*Maesopsis eminii*	3
	Tetrapleura tetraptera	3	Earache	*Aframomum daniellii*	2
	Trichoscypha acuminata	3		*Hunteria umbellata*	2

3.2.3. Service Plants

Nineteen plant species were identified as service plants. They belong to 15 families, of which Annonaceae, Arecaceae, Euphorbiaceae and Fabaceae each have 2 species (Table 4). Of the plant species listed as service plants, *Marantochloa cordifolia* (K. Schum.) Koechlin (45 citations) is the most popular. It is followed

Table 4. Service plants found in the Gribé populations.

Scientific names	Names ver/com	Families	Types of use					Requested parties						Floristic characteristics					Nq
			Cma	Ama	Mcu	Pac	Fur	fr	st	ro	le	bk	br/tr	BT	BTI	PT	DT	MD	
Cleistopholis glauca Pierre ex Engl. & Diels	Sembequi	Annonaceae				*						*		Tr	Pf	Gc	Sar	Zoo	4
Corynanthe pachyceras K. Schum.	Wassassa	Rubiaceae				*					*			Tr	Pf	Gc	Scle	Ane	1
Detarium macrocarpum Harms	Mbili	Fabaceae				*								Tr	Pf	Gc	Sar	Zoo	17
Drypetes aframensis Hutch.	Olelam	Euphorbiaceae	*										*	Tr	Pf	Gc	Sar	Zoo	1
Entandrophragma cylindricum Sprague	Boyo	Meliaceae			*								*	Tr	Pf	Gc	Pte	Ane	33
Gongronema latifolium Benth.		Asclepiadaceae				*			*					Ag	Pf	Sz	Sar	Zoo	7
Greenwayodendron suaveolens (Engl. & Diels) Verdc.	Gbotunga	Annonaceae	*		*								*	Tr	Pf	Gc	Sar	Zoo	15
Heisteria zimmereri Engl.	Molomba,	Olacaceae	*										*	Tr	Pf	Wg	Sar	Zoo	2
Irvingia gabonensis	Pféké	Irvingiaceae					*						*	Tr	Pf	Gc	Sar	Zoo	4
Laccosperma secundiflorum (P. Beauv.) Kuntze	Kawo	Arecaceae					*		*					Li	Pf	At	Sar	Zoo	10
Marantochloa cordifolia (K. Schum.) Koechlin	Boboko2	Marantaceae				*			*		*			Pg	Pf	Gc	Sar	Zoo	45
Margaritaria discoidea (Baill.) Webster	Kango	Euphorbiaceae	*										*	Tr	Fs	Am	Sar	Zoo	1
Massularia acuminata (G. Don) Bullock	Mindo	Rubiaceae		*	*								*	Ag	Pf	Gc	Sar	Zoo	31
Megaphrynium macrostachyum (Benth.) Milne-Redh.	Ngongo	Marantaceae				*					*			Pg	Pf	Gc	Sar	Zoo	33
Millettia sanagana Harms	Nganda	Fabaceae	*										*	Tr	Pf	Wg	Bal	Aut	1
Raphia regalis Becc.	Kpwa/Péké	Arecaceae				*					*			Ag	Hyf	Gc	Sar	Zoo	16
Streblus usambarensis (Engl.) C. C. Berg	Ndoundou	Moraceae	*										*	Ag	Pf	Gc	Sar	Zoo	17
Strychnos spinosa Lam.	Monkey Orange	Loganiaceae			*			*						Ag	Pf	Sz	Sar	Zoo	6
Terminalia superba Engl. & Diels	Ngolou	Combretaceae			*					*				Tr	Pf	Gc	Pte	Ane	7

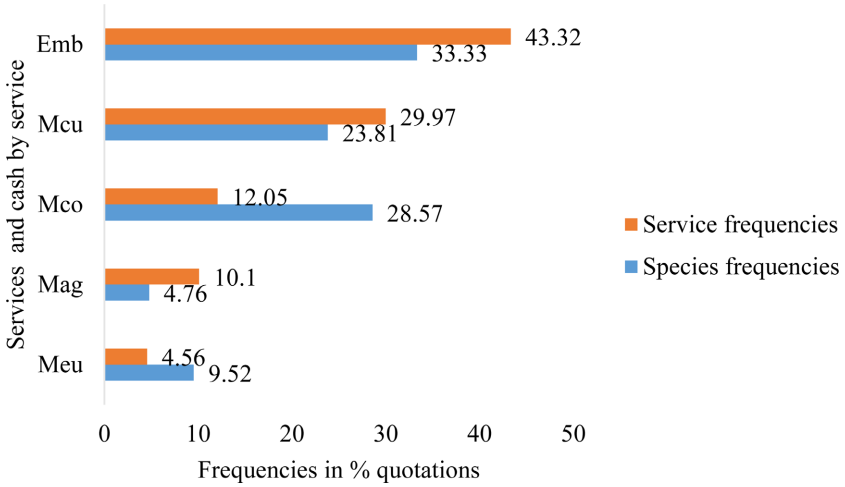
Key: Cma = Construction material, Ama = Agricultural material, Mcu = Kitchen material, Pac = Packaging, Fur = Furniture, fr = fruit, st = stem, ro = root, le = leaf, bk = bark, br/tr = branch/trunk, BT = Biological type (Tr = Tree, Ag = Annual grass, Pg = Perennial grass, Sb = shrub, Li = Liana, Ss = Sub shrub), BTI = Biotope type (Pf = Primary forest, Fs = Secondary forest, Ff = Forest fallow, Hyf = Hydromorphic forest), PT = Phytogeographic type (Gc = Centro-Guineo-Congolese, Am = Afro-Malgache, WG = Western Guinean), DT = diasporous type (Sar = Sacochore, Pte = Pterochore, Bal = Ballochore), MD = Modes of dissemination of diaspores (Zoo = Zoochory, Ane = Anemochory, Aut = Autochory), Nq = Number of quotes.

by *Entandrophragma cylindricum* Sprague and *Megaphrynium macrostachyum* (Benth.) Milne-Redh. (33 citations each). Next came *Massularia acuminata* (G. Don) Bullock (31 citations), *Streblus usambarensis* (Engl.) C. C. Berget and *De-*

tarium macrocarpum Harms (17 citations each), *Raphia regalis* Becc. (16 citations) and *Greenwayodendron suaveolens* (Engl. & Diels) Verdc. (15 citations) (Table 4).

The service plants surveyed in the Baka households of Gribé gave rise to 23 recipes, of which "digging and pruning the trunk of *Entandrophragma cylindricum* to obtain the shape of a mortar" and "pruning the branch of *Massularia acuminata* to obtain a pestle" were the most cited, with 30 and 29 citations respectively. The recipes for "covering huts with *Marantochloa cordifolia* leaves" and "using *Marantochloa cordifolia* leaves to wrap products" were cited by 22 and 21 households respectively.

The various recipes were prepared to satisfy five main uses. Figure 7 illustrates the types of use of service plants and shows the number of plants requested for each use. Interpretation of this figure shows that product packaging (43.32%) is the most frequently cited use in Baka households in Gribé.This use calls for 7 plants (*i.e.* 33.33% of the plants requested). Six plants (*i.e.* 28.57% of species) are solicited for the use of construction material, which represents only 12.00% of the uses mentioned by the Baka of Gribé (Figure 7).



Key: Emb = Packaging, Mcu = Kitchen equipment, Mco = Construction equipment, Mag = Agricultural equipment, Meu = Furniture.

Figure 7. Proportion of service plant uses.

Plant organs of service plants

In their use of service plants, Baka households in Gribé make use of six plant parts, which include: branches and/or trunks, buttresses, leaves, stems, bark and fruit. Of these organs or parts, branches/trunks, leaves and stems are the most frequently used, with frequencies of quotation of 37.63%, 34.05% and 22.22% respectively (Figure 8).

3.2.4. Floristic Characteristics of Plants Used in Baka Households in Gribé

The surveyed florula in the Baka households of Gribé were characterised by biological types, phytogeographical distribution types as well as diaspora distribution

types and modes.

Six morphological types were distinguished, including trees (Ar), shrubs (Aa), sub-shrubs (Sa), lianas (Lia), perennial grasses (Hv) and annual grasses (Ha). The 53 trees represent 62.35% of the morphological types. They are followed by shrubs (11 or 12.94%) and lianas (9 or 10.59%). Annual grasses represent only 1.18% (Figure 9).

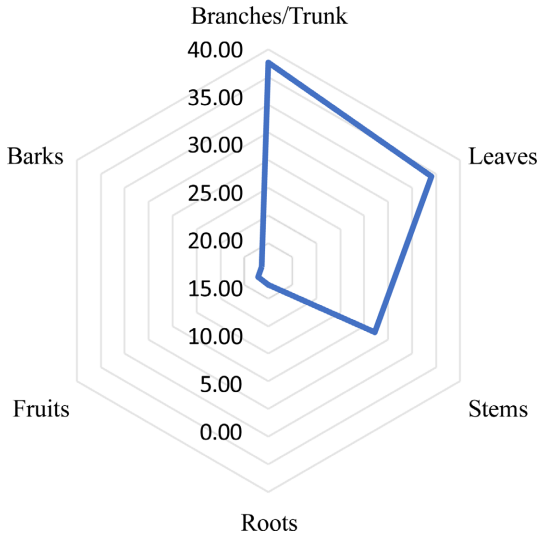
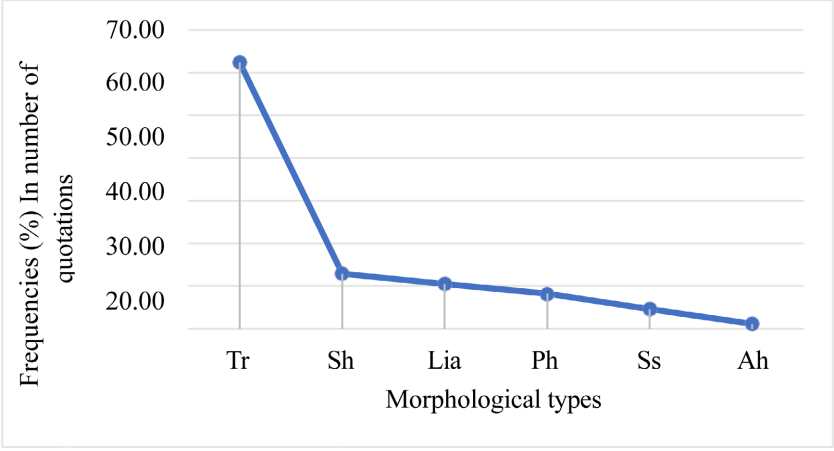


Figure 8. Plant parts of service plants.



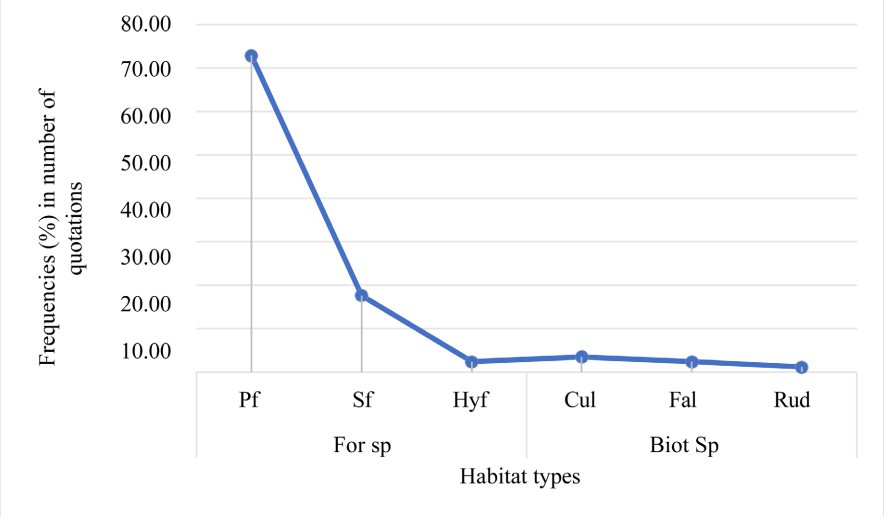
Key: Trees (Tr), Shrubs (Sb), Sub-shrubs (Ss), Liana (Lia), Perennial herbs (Ph), Annual herbs (Ah).

Figure 9. Morphological types.

Six habitat types are home to the NTFPs cited in the Baka households of Gribé. These are very little disturbed dense forest species (primary forests) (72.94%), disturbed dense forest species (secondary forests) (17.65%), hydromorphic forest species (2.35%), cultivated species (3.53%), fallow species (2.35%) and ruderal species (1.18%). Forest species, numbering 79, account for 92.94% of species cited in Baka households in Gribé, and among species of other biotopes, cultivated spe-

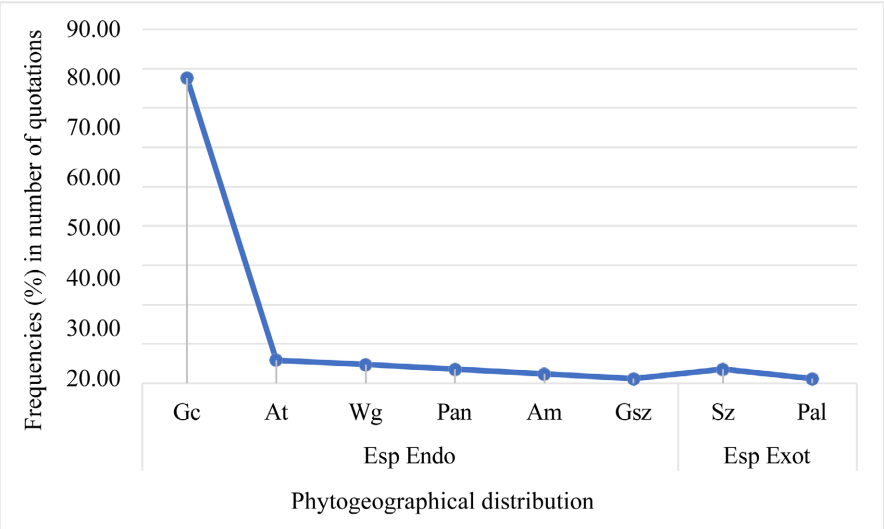
cies, of which there are 03, are the most represented (Figure 10).

Eight phytogeographical types were distinguished among the plants cited by the Baka of Gribé. These were Afromalagasy (2.35%), Afrotropical (5.88%), Centroguineo-Congolese (77.65%), Guinean and Sudano-Zambian (1.18%), Western-Guinean (4.71%), Palaeotropical (1.18%), Pantropical (3.53%) and Sudano-Zambian (3.53%) species. Endemic species (Gc, At, Wg, Pan, Am and Gsz) dominate (95.29%), with 66 of them being Centroguineo-Congolian (Figure 11).



Key: Primary forest (Pf), Secondary forest (Sf), Hydromorphic forest (Hyf), cultivated species (Cul), Fallow (Fal), Ruderale species (Rud), Forest species (For Sp), Other biotopes species (Biot Sp).

Figure 10. Habitat types of species inventoried at Gribé.



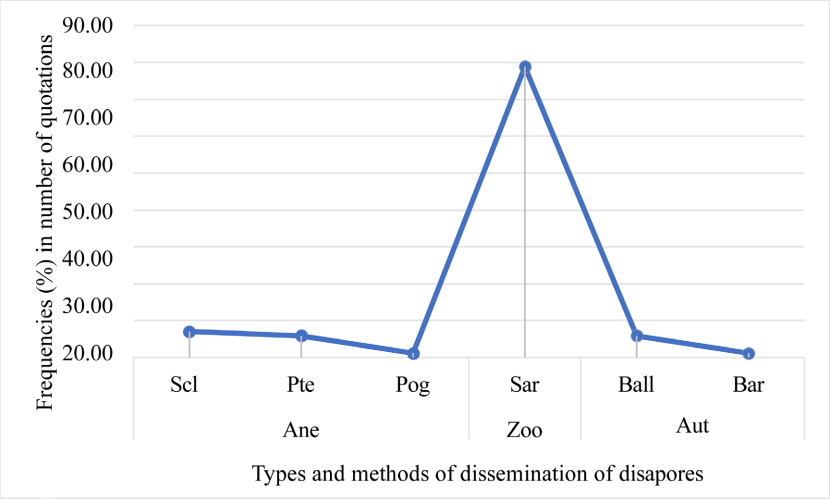
Key: Esp Endo = Endogenous species, Esp Exot = Exotic species, Gc = Centro-Guineo-Congolese, Am = Afro-Malagasy, At = Afro-tropical, Wg = Western Guinean, Pan = Pan-tropical, Paleo = Paleo-tropical, Gsz = Guineo-Sudano-Zambezian, Sz = Sudano-Zambezian.

Figure 11. Phytogeographical distribution of species used in Baka households in Gribé.

Six types of diaspora were distinguished among the NTFPs cited by Baka households in Gribé. These were ballochores (5.88%), barochores (1.18%), pogonochores (1.18%), pterochores (5.88%), sarcochores (78.82%) and sclerochores (7.06%). Sarcochores are spread by zoochory, which at 78.82% is the main mode of dissemination. Sclerochores, pterochorores and pogonochores are spread by wind (anemochory), accounting for 14.12% of the modes of spread (Figure 12).

3.3. Relative Importance of Plant Species in Usage

Figure 13 illustrates the relative importance of plant species in the plant uses of Baka households in Gribé. Species with a percentage ≥ 2 are shown. *Marantochloa cordifolia* is the most important species cited in the uses of Baka households. It accounts



Key: Sarcochores (Sar), Barochores (Bar), Ballochores (Bal), Pogonochores (Pog), Sclerochores (Scl), Pterochores (Pte), Anemochoria (Ane), Autochoria (Aut), Zoochoria (Zoo).

Figure 12. Types and methods of diaspora dissemination.

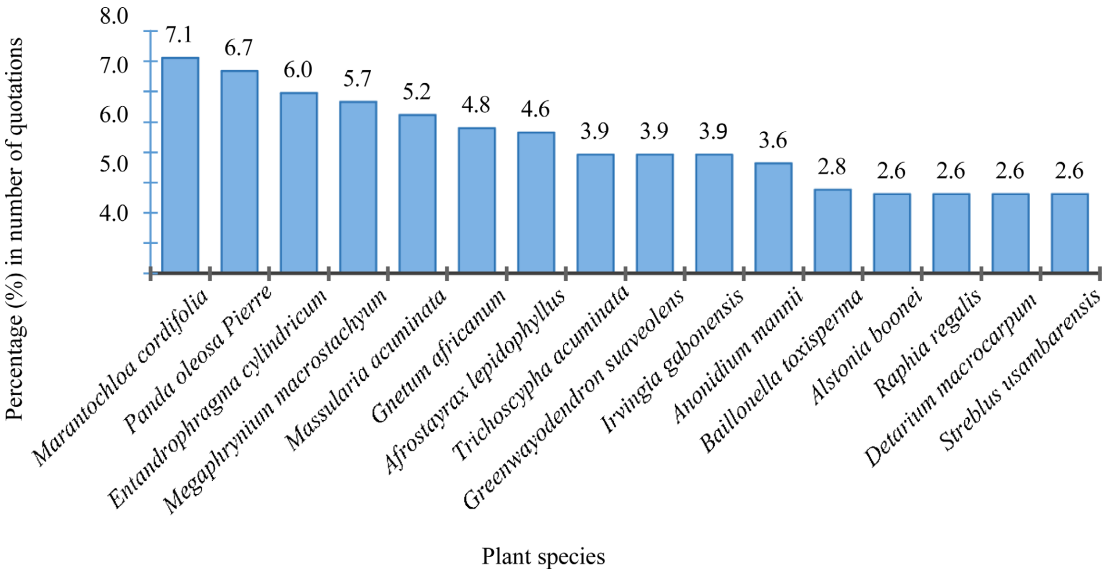


Figure 13. Relative importance of plant species in uses.

for 7.1% of citations. Next come *Panda oleosa* with 6.1%, and *Entandrophragma cylindricum* with 6.00% of citations.

The ethnobotanical use values of the species identified in the Baka households of Gribé were calculated. Fourteen species have the most significant use values. In ascending order, they are *Entandrophragma cylindricum* (VU = 1.25), *Massularia acuminata* (VU = 1.13), *Panda oleosa* (VU = 1.03), *Gnetum africanum* (VU = 1.00), *Marantochloa cordifolia* (VU = 0.94), *Trichoscypha acuminata* (VU = 0.91), *Irvingia gabonensis* (VU = 0. 81), *Anonidium mannii* (VU = 0.78), *Greenwayodendron suaveolens* (0.78), *Afrostyrax lepidophyllus* (VU = 0.75), *Megaphrynium macrostachyum* (VU = 0.78), *Detarium macrocarpum* (VU = 0.56), *Raphia regalis* (VU = 0.56), *Streblus usambarensis* (VU = 0.56). Table 5 shows the species with use values greater than or equal to 0.1 (VU ≥ 0.1).

3.4. Description of Organ Harvesting Activities

Harvesting practices were described in terms of three parameters: plant organs harvested, harvesting methods and techniques, and harvesting areas. Eight plant organs were harvested by the Gribé people to make the various recipes. Figure 14 illustrates the frequency with which the different plant organs taken from the plants used in Gribé are cited. The figure shows that when the parameter "species from which the organs are taken" is taken into account, bark is the most frequently cited (43.24%). Bark was used for 48 species. On the other hand, when it comes to the "revenue" parameter, fruit (33.76%) is the organ most used (Figure 14). Surveys on the availability or otherwise of plant organs requested by the Gribé populations reveal that they are available (66.45%) (much more so for leaves and bark), seasonal (28.21%) (for fruit), rare (3.63%) (for roots and trunks) and very rare (1.71%) (for trunks).

Figure 15 illustrates the harvesting methods and techniques observed. Picking (54.06%) was the harvesting method most commonly used by the Gribé populations. In the picking mode, the figure illustrates a number of harvesting techniques: scraping the bark (1.91%), debarking the tree (19.48%), notching the bark (2.18%), stripping leaves and stems (19.04%), uprooting (1.83%), cutting branches (7.60%) and felling the tree (2.01%). Collecting fruit and/or seeds.

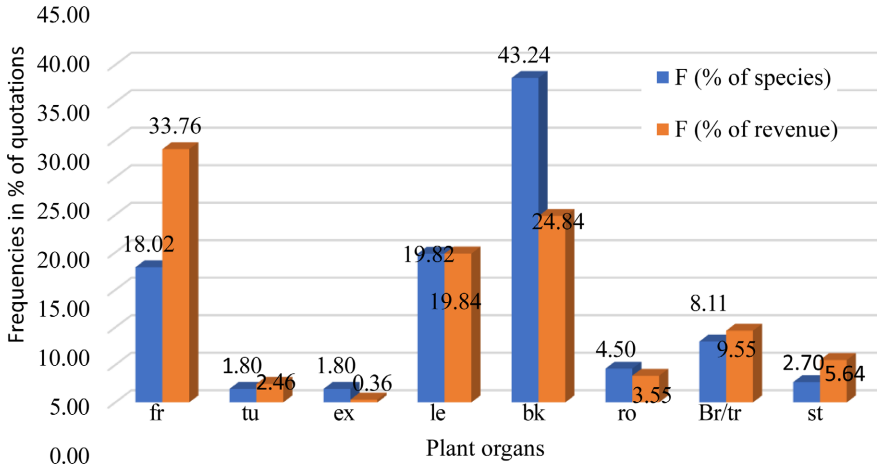
Trunks and/or branches were the most popular areas for harvesting organs (61.38%). The debarking technique used in these areas was monitored and described. Figure 15 shows the different debarking techniques. Analysis of this figure shows that 1/4 debarking is the technique most widely used by farmers. Anarchic debarking (21.00%) is practised and anhelation of the tree represents only 1.00% of the practices adopted by the Gribé farmers (Figure 16).

4. Discussion

This study highlighted the different uses of wild plants in Baka communities, more specifically in the village of Gribé in the East Cameroon Region. The surveys carried out in Gribé involved 178 informants, 65.74% of whom were men aged

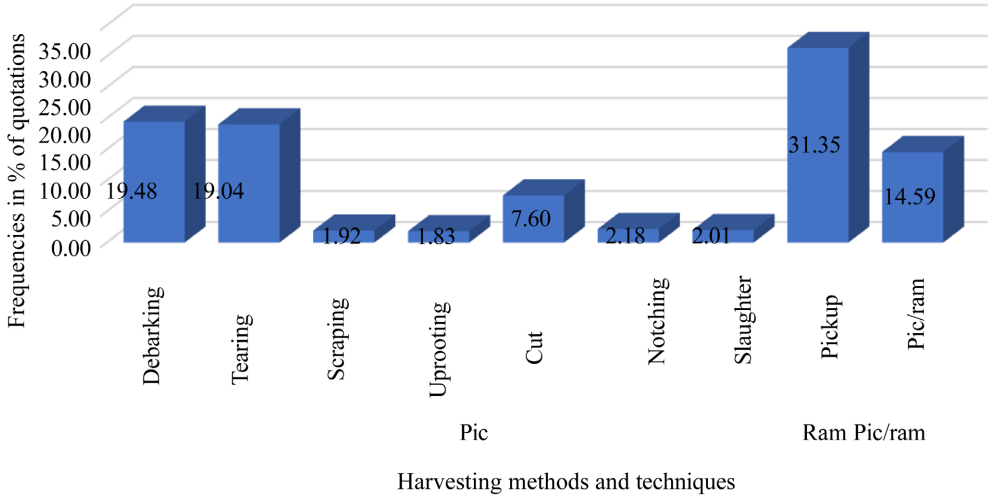
Table 5. Ethnobotanical use value of plant species found in Baka households in Gribé.

Species no.	Plantspecies	VU
1	*Entandrophragma cylindricum* (Sprague) Sprague.	1.25
2	*Massularia acuminata* (G. Don) Bullock ex Hoyle	1.13
3	*Panda oleosa* Pierre	1.03
4	*Gnetum africanum* Welw.	1.00
5	*Marantochloa cordifolia* (K. Schum.) Koechlin	0.94
6	*Trichoscypha acuminata* Engl.	0.91
7	*Irvingia gabonensis* (Aub. Lec. ex O'R) Bail.	0.81
8	*Anonidium mannii* (Oliv.) Engl. & Diels	0.78
9	*Greenwayodendron suaveolens* (Engl. & Diels) Verdc.	0.78
10	*Afrostyrax lepidophyllus* Mildbr.	0.75
11	*Megaphrynium macrostachyum* (Benth.) Milne-Redh.	0.78
12	*Detarium macrocarpum* Harms	0.56
13	*Raphia regalis* Beec	0.56
14	*Streblus usambarensis* (Engl.) C. C. Berg	0.56
15	*Alstonia boonei* De Wild.	0.47
16	*Baillonella toxisperma* Pierre	0.47
17	*Corynanthe pachyceras* K. Schum.	0.41
18	*Dioscorea burkilhana* Miège	0.41
19	*Dioscorea cayenensis subsp. rotundata* (poir.) J. Miège	0.41
20	*Laccosperma secundiflorum* (P. Beauv.) Küntze	0.38
21	*Terminalia superba* Engl. & Diels	0.31
22	*Trichoscypha arborea* (A. Chev.) A. Chev.	0.31
23	*Gongronema latifolium* Bonth.	0.25
24	*Diospyros crassiflora* Hiern	0.22
25	*Strychnos spinosa* Lam	0.22
26	*Tetrapleura tetraptera* (Schum. & Thonn.) Taub.	0.22
27	*Croton oligandrus* Pierre ex Hutch.	0.19
28	*Pycnanthus angolensis* (Welw.) Warb.	0.19
29	*Drypetes gossweileri* S. Moore	0.16
30	*Hunteria umbellata* (K. Schum.) Hallier f.	0.16
31	*Aframomum daniellii* (Hook. f.) K. Schum.	0.13
32	*Annickia affinis* (Exell) Versteegh & Sosef	0.13
33	*Cleistopholis glauca* Pierre ex Engl. & Diels	0.13
34	*Cylicodiscus gabunensis* Harms	0.13



Key: F = Frequency, fr = Fruits, tu = Tubers, ex = Exudates, le = Leaves, bk = Bark, ro = Roots, st = Stems, Br/tr = Branches/trunks.

Figure 14. Plant organs used in Gribé households.



Key: Pic = Picking, Ram = Ramming, Pic/ram = Picking/ramming.

Figure 15. Harvesting techniques adopted by the populations of Gribé.

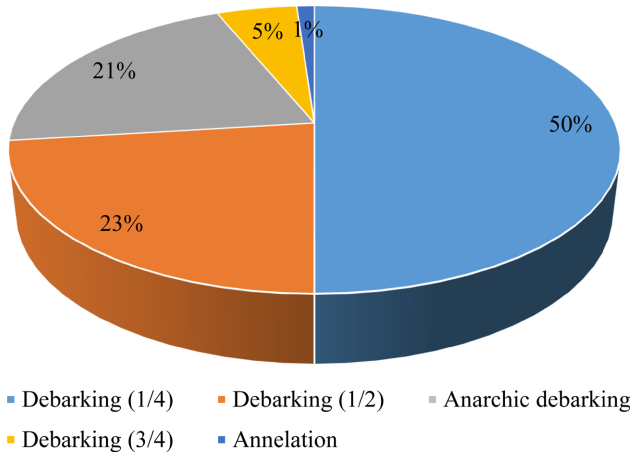


Figure 16. Debarking techniques used by Gribé farmer.

between [40 - 85[years (84.26%). They lived mainly from gathering and/or collecting (43.25%), but were also farmers, traditional healers and hunters. These results are similar to those of [12], who found in a survey of medicinal plants in Gribé that 68.18% of respondents were men. [39] found similar results. Although women are much more involved in gathering and collecting organs, men are more dependent on the use of plants. Older men have very in-depth knowledge of plant use, which they share independently of kinship when it comes to edible plants or services, whereas knowledge of medicinal plants remains within the nuclear family [39]-[41].

Furthermore, the high proportion of adults (38.76%) testifies to the great interest in perpetuating knowledge about the virtues and uses of plants. This also testifies to the important place that NTFPs occupy within rural communities, irrespective of the age and profession of the people living there [42]-[45].

The Baka people of Gribé have a good knowledge of the resources and names of the species in their natural environment. The vernacular names of the various species inventoried are sufficient proof of the strong relationship that exists between this community and the species that surround them. [24] has already pointed out the importance of exploiting the plants available in the biotope closest to the farmers, which would enable them to obtain more quickly the organs they need to prepare their recipes. In addition, Betti *et al.* point out that people living near the forests of the Congo Basin are very familiar with the species in their ecosystems, as well as the different uses they can make of them [46]. However, given the short period over which the surveys were conducted, there is a high probability that the use of certain species will escape the respondents' memory, especially if they are rarely consumed during the interview period. [12] inventoried 132 species simply for medicinal use, which is twice the number of species surveyed in this study for the same use.

The work of [39], which was carried out over a long period and focused on the Baka peoples of various villages in eastern Cameroon, identified four times as many species for edible use as were identified in this study for the same purpose. However, species such as moabi (*Baillonella toxisperma),* cola nut (*Cola acuminata)*, bitter cola (*Garcinia kola*), koko (*Gnetum africanum*), bush mango (*Irvingia gabonensis*), Njangsang (*Ricinodendron heudelotii*), aidon tree (*Tetrapleura tetraptera*) and kana (*Panda oleosa)* identified in this study have all been reported in the works of [46] and [39] as having high scores. [42] and [47] already found in their work that *Cola acuminate*, *Ricinodendron heudelotii* and *Irvingia* spp. were the most prominent species after *Dacryodes edulis* in terms of both quantity and value.

Sixty-two plant species have been recorded as medicinal plants in Gribé. They belong to 32 families, the most represented being Euphorbiaceae, Fabaceae, Annonaceae, Moraceae, Rubiaceae, Apocynaceae and Zingiberaceae. In their work on the use of medicinal plants by the Baka of southern and eastern Cameroon, [48] already presented the Fabaceae, Annonaceae, Euphorbiaceae and Apocyna-

ceae as the most representative families of medicinal species. [12] arrived at similar results to Gribé. The predominance of these families shows that the village of Gribé belongs to the dense humid semi-caducifoliate forests. It also reveals the interest that African pharmacopoeia places in these families, which provide it with numerous bioactive compounds of interest [21] [49] [50].

Alstonia boonei is the most popular medicinal species at Gribé. It is followed by *Greenwayodendron suaveolens* and *Tetrapleura tetraptera*. [12] also find that *Alstonia boonei* is a much sought-after medicinal species in Gribé. Afiong *et al.* confirmed this result [48]. The bark of Ekouk (*Alstonia boonei*) contains indole alkaloids (Echitamine and Echitamidine) and terpene compounds that have not only antimicrobial but also anti-inflammatory properties [51] [52]. The bark of this plant is highly prized in the treatment of malaria with chronic diarrhoea. It is all the more effective when combined with *Entandrophragma cylindricum* and *Hunteria umbellata* bark in the treatment of this condition.

Elaies guineensis and Capsicum frutescens with 16 and 17 citations respectively are the third and fourth medicinal plants of interest in Gribé. [12] [21] [48] [49] also find that these two plants are of great interest in traditional Cameroonian pharmacopoeia. The results show that in Gribé, they are used exclusively as auxiliary or adjuvant ingredients in recipes. The combination of these plants in medicinal recipes reinforces the therapeutic action of the main components of these recipes and treats the secondary symptoms of the disease. *Elaies guineensis* palm kernel oil is a powerful antipyretic, reducing fever in children. The Baka women of Gribé also mention that this oil is a powerful antihistamine. It is mixed with *Piper umbellatum* leaves and used as a suppository to treat haemorrhoids [49]. The capsaicin present in *Capsicum frutescens* is thought to have an anti-inflammatory effect comparable to that of diclofenac [53]. In addition, the phenolic and terpene compounds in the small cayenne pepper are thought to give it remarkable properties, which could justify its antimicrobial and antifungal activities [54].

Of the eight disease groups found, the Infectious and Parasitic Diseases (IPD) group (28 plants) is the most represented. It alone accounts for the contribution of 27 plants. Within this disease group, malaria and dysentery accounted for 20.63% and 10.05% respectively of ailments recorded at Gribé. A number of plants performed well in treating these conditions. These included *Alstonia boonei, Celtis mildbraedii, Entandrophragma cylindricum, Irvingia gabonensis, Monodora crispata, Ricinodendron heudelotii for malaria and Angylocalyx vermeulenii*, *Greenwayodendron suaveolens*, *Klainedoxa gabonensis, Maesopsis eminii*, *Manniophytom fulvum*, *Maranthochloa purpurea*, *Plagiostyles africana*, *Santiria trimera*, *Schumanniophyton magnificum* for dysentery. Recourse to these plants is justified by the absence of health centers, their remoteness or, precisely, by the lack of financial means to travel to them. Pharmacopoeia would thus be the alternative of choice for primary health care. [20] [24] [55] already reported that these two diseases were the most commonly treated by plants sold in urban markets in rural areas, precisely among the Baka of southern and eastern Cameroon, malaria and diarrhoea have also been

reported as the diseases most frequently treated by the plants inventoried [48]. The results of [12] and [48] confirm Cameroon's status as a malaria-endemic zone. [56] also finds that *Alstonia boonei* is a plant indicated for the treatment of malaria. [48] [55] find with the same index (Ip = 2) that this plant performs well in treating this disease. However, although [12] listed malaria as one of the most common illnesses in Gribé, it does not appear in the results of these authors as the illness most treated by Gribé plants. Instead, they found sexual weakness, cough, backache and asthenia to be the illnesses most commonly treated with Gribé plants, with malaria ranking only eighth.

The bark is the plant organ most frequently used in recipes where the main preparation method is decoction. Along with roots, bark is the ideal storage organ for bioactive compounds [21] [49]. Moreover, their non-seasonal characteristics make them organs that are always available, compared with flowers and fruits. Leaves also play a key role in the preparation of plant-based recipes. They are the place where bioactive metabolites are synthesized, and for this reason, some Baka respondents mentioned that the ideal time to harvest the leaves to be used in preparing the medicine is "very early in the morning", when they still concentrate large quantities of active ingredients. In addition to the importance attached to a species, its vulnerability is also correlated with the type of organs used, the way recipes are prepared (especially in the case of medicinal recipes), and the methods and techniques used to harvest the organs. Organs are thus classified, according to their importance for the plant's survival, into organs whose exploitation is highly detrimental: roots, whole plant, young shoots; organs whose exploitation is detrimental: stem bark and sap; organs whose exploitation is little or not detrimental: leaves, flowers, seeds, nuts, bulbs [57]. As for pharmaceutical forms, liquid medicines have a greater impact on the vulnerability of the species than solid forms, due to their poor preservation, which results in a high level of organ removal. Thus, powders, ashes or ointments can be preserved for longer than macerated or decotted products.

Investigations carried out among Baka households in Gribé identified 23 plant species used as service plants, which were the subject of 29 recipes. *Entandrophragma cylindricum*, *Massularia acuminata* and *Marantochloa cordifolia* are the most widely used species. Stems are the plant parts most used as service plants by Baka households. Branches/trunks, leaves and stems are the most solicited organs with respective citation frequencies of 37.63%, 34.05% and 22.22%. [58] already found that branches and stems were in high demand for handicrafts and habitat construction. Branches and stems are used as support poles, framing poles, hoe handles and traditional axes. Two species, *Corynanthe pachyceras* and *Irvingia gabonensis*, are used as support poles, *Greenwayodendron suaveolens* is used as a framework pole, *Entandrophragma cylindricum* and *Massularia acuminata* are used to make mortars, pestles, hoe handles and the traditional Baka axe. These results corroborate those found by [42] and [59].

Fifteen species have multiple uses. They are used either as edible or medicinal

plants, or as service and medicinal plants, or as edible and service plants. These include *Aframomum daniellii*, *Afrostyrax lepidophyllus*, *Anonidium mannii*, *Chrysophyllum lacourtianum*, *Corynanthe pachyceras*, *Entandrophragma cylindricum*, *Greenwayodendron suaveolens*, *Irvingia gabonensis*, *Massularia acuminata*, *Millettia sanagana*, *Panda oleosa*, *Raphia regalis*, *Ricinodendron heudelotii*, *Terminalia superba*, *Trichoscypha acuminata*. These plants also showed significant use values (VU ≥ 0.5). *Irvingia gabonensis* is the only species solicited for all three use categories. [58] already found in the NTFP florule of the Haut-Sassandra classified forest in Côte d'Ivoire that *Irvingia gabonensis* and *Ricinodendron heudelotii* were solicited for multiple uses. As well as being medicinal plants, the kernels of these two species are much in demand for cooking sauces to accompany meat or fish dishes, and are therefore highly consumed in urban centers. According to [42], their sale is a significant source of income for Gribé households.

The floristic traits of the species help to determine their vulnerability. The distribution of species according to morphological type shows a strong predominance of woody species (85.88%). Most of these are endemic species (95.29%) from forests (92.94%), spread by zoochory (78.82%). Woody species are highly vulnerable, regenerating very slowly and degenerating very rapidly when poorly exploited awareness-raising and even training of residents in harvesting techniques [38] [21]. The advantage of harvesting these species lies in the fact that they offer the farmer the possibility of having at least one organ available at each time of year, hence the interest in further research into the different organs of woody species. Data on the phytogeographical distribution of the species surveyed in Gribé clearly show that this village belongs to the Guineo-Congolese domain. This result corroborates that linked to the biotope of the species surveyed and shows that the inhabitants of Gribé exploit the plants available in their biotope, enabling them to more rapidly obtain the organs they need to prepare recipes [21] [24] [59]. Furthermore, the rarity of wide-ranging species would indicate a low level of degradation or modification of the landscape. This element could also be an indicator of the conservation of local pharmacopoeia know-how [24]. The importance of zoochorous species shows, on the one hand, their forest origin and, on the other, the important role of wildlife in forest regeneration [23] [38] [49] [50].

Several harvesting techniques impact on the regenerative capacity of the organs, considerably affecting the plant's development. Anarchic or simple debarking (21.00%) appears to be the most important technique adopted by NTFP operators in Gribé. This technique causes the tree to wither in the more or less long term [60]. In addition, 3/4 debarking (5.00%) and uprooting (1.83%) are techniques that are detrimental to the survival and sustainability of the species. Indeed, harvesting bark from the entire outer circumference of the tree can more or less lead to the tree's death [61]. Woody species such as *Irvingia gabonensis*, which are highly prized for their bark and seeds, are under heavy pressure. High-intensity organ harvesting could have an impact on the long-term availability of such species. This phenomenon was observed by [49] when, in a village in central France, excessive debarking

of *Erythrophleum suaveolens* to treat haemorrhoidal ailments led to the disappearance of individuals. Tree trunks are by far the most coveted areas for harvesting organs. The accessibility of an organ influences its use within a community, leading to an increase in the frequency of harvesting and the quantities harvested, which are factors in degradation [62].

5. Conclusions

The indigenous communities of Gribé use the species around them for both food and medicinal purposes. These species also provide many services to Gribé. *Aframomum daniellii*, *Afrostyrax lepidophyllus*, *Anonidium mannii*, *Chrysophyllum lacourtianum*, *Corynanthe pachyceras*, *Entandrophragma cylindricum*, *Greenwayodendron suaveolens*, *Irvingia gabonensis*, *Massularia acuminata*, *Millettia sanagana*, *Panda oleosa*, *Raphia regalis*, *Ricinodendron heudelotii*, *Terminalia superba*, and *Trichoscypha acuminate* are put to a wide variety of uses. These species require special attention and harvesting methods that do not undermine their sustainability, especially as NTFPs are vital for the subsistence of the Gribé populations, who are heavily dependent on them.

The unavailability of these products could have a negative impact on the quality of life of these populations. These results show the need to involve local populations in biodiversity management and conservation strategies. Popularising conservation techniques for these species would be an important approach to guaranteeing their availability.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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